PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-018787

(43)Date of publication of application : 17.01.2003

(51)Int.Cl. H02K 5/15
F16C 17/10
H02K 5/16
H02K 5/167
H02K 7/08
H02K 29/00

(21)Application number : 2001-198170

(22)Date of filing : 29.06.2001

(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD

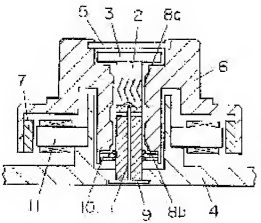
(72)Inventor : WAKITANI AKIHIKO

(54) BRUSHLESS MOTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a motor for HDD, which excels in high vibration accuracy, power saving, low noise, and resistivity against mechanical impact.

SOLUTION: A gas-dynamic-pressure bearing is constituted by using two bearings of a radial bearing and a thrust bearing for supporting a shaft 2 which supports a hub 6, and the hub 6; a space region of a gas-dynamic-pressure bearing part is constituted inside the hub by disposing magneto-hydro seals on both ends or one at least on either end of the part constituting the gas- dynamic-pressure bearing; and a communicating hole 1 from the outside to the space region is provided on the shaft 2.



Notes:
1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

Translated: 23:39:15 JST 09/04/2008
Dictionary: Last updated 08/06/2008 / Priority: 1. Electronic engineering

FULL CONTENTS

[Claim(s)]

[Claim 1] The hub which carries a magnetic disk and is rotated, and said hub and the magnet which rotates by one, The shaft which supports said hub, and in order to support said hub, use two radial bearings and thrust bearings and a gas dynamic pressure bearing is constituted. The BURASHIRESU motor which constitutes the space field of a gas dynamic pressure bearing part in said hub inner side, and is characterized by preparing the free passage hole from the open air to [said shaft] said space field by installing a magnetic fluid seal in at least the both ends or one end of a part which constitutes said gas dynamic pressure bearing.

[Claim 2] The BURASHIRESU motor according to claim 1 by which a free passage hole is an approximate circle form, and the relation between D1/D2 <=0.3 is materialized by the diameter D1 of said free passage hole to the diameter D2 of said shaft.

[Claim 3] The hub which carries a magnetic disk and is rotated, and said hub and the magnet which rotates by one, The shaft which supports said hub, and in order to support said hub, use two radial bearings and thrust bearings and a gas dynamic pressure bearing is constituted. The space field of a gas dynamic pressure bearing part is constituted in said hub inner side by installing a magnetic fluid seal in at least the both ends or one end of a part which constitutes said gas dynamic pressure bearing. The BURASHIRESU motor characterized by preparing the free passage hole from the open air to said space field in the part which counters said shaft peripheral face.

[Claim 4] A BURASHIRESU motor given in either of Claim 1 by which the opening part of a free passage hole is installed between two radial bearings to 3.

[Claim 5] A BURASHIRESU motor given in either of Claim 1 which has a ventilation filter to the opening part of a free passage hole to 3.

[Claim 6] The BURASHIRESU motor according to claim 3 from which a free passage hole constitutes a labyrinth seal according to a hub face and the stator side which counters said hub face in the opening part which results in the open air.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the BURASHIRESU motor (it abbreviates to a motor hereafter) mainly used for a magnetic-disk driving device.

[0002]

[Description of the Prior Art] As technology which high precision is strongly demanded of the motor which drives a magnetic disk with the reduction in high-capacity-izing of the HDD apparatus of OA field, improvement in the speed, highly-precise-izing, and noise, and meets this demand in recent years In the bearing constituted between a hub and a shaft, adopting the dynamic pressure bearing using a liquid or gas is examined.

[0003] As a motor, what was indicated to JP,H7-326121,A is known conventionally. The structure of the conventional motor is shown in drawing 10 . In drawing 10 , the shaft 2, the hub 6 supported through two ball bearings 16, the spindle hub drive motor 17 with which the space field of the inner side central part of the hub 6 was equipped, and the outside of a ball bearing 16 are equipped with the magnetic fluid seal 10 through predetermined space. The open air part vent hole 18 from the bracket 4 side to the space field of spindle hub drive motor 17 portion is established in the shaft 2.

[0004] Thus, by constituting, it prevents that the grease of a ball bearing and some magnetic fluid seals disperse.

[0005]

[Problem to be solved by the invention] The storage capacity of a magnetic-disk driving device increases at an increasing tempo, and the track pitch of the magnetic disk is also narrow with the increase in the storage capacity of equipment in recent years. In order to trace this narrowing track pitch top certainly, high precision rotation is demanded of the motor carried in a magnetic-disk driving device. It is one of the typical characteristics indispensable to reading certainly the narrow track pitch on the rotating magnetic disk, submicron high precision is required, and especially the NRRO (non-reproducibility repetition deflection) characteristics of a motor have big influence on the storage capacity densification of a magnetic-disk driving device.

[0006] Moreover, while the track pitch of a magnetic disk narrows, the magnetic head of a magnetic-disk driving device and the crevice between the rotating magnetic disks are also becoming narrow every year. It dust enters said crevice, fault, like a magnetic disk or a magnetic head gets damaged is produced, and reading and writing of a magnetic-disk driving device become impossible normally. In recent years, the demand to the air cleanliness class of a motor is also severe so that such fault may not be produced.

[0007] Moreover, it may be used in order to carry some magnetic-disk driving devices in recent years in a personal computer (it abbreviates to PC hereafter), or AV equipment and to record and play an animation. When a magnetic-disk driving device treats an animation, in order that the user of PC or AV equipment may play an animation comfortably, it is indispensable to carry out the access speed of a magnetic-disk driving device early, and in order to make an access speed increase, the high velocity revolution of the motor is demanded.

[0008] Moreover, when a magnetic-disk driving device is carried in PC, AV equipment, etc., in order that the user of apparatus may use it comfortably, silence nature is indispensable, and in order to improve silence nature, low noise-ization is demanded of the motor which makes a magnetic-disk driving device drive.

[0009] Moreover, when a magnetic-disk driving device is miniaturized, is thin-shape-ized and carries a

magnetic disk of 2.5 inches or less, it may be included in mobile computing devices etc. and may be carried. In such a case, there is a possibility of dropping mobile computing devices accidentally from on a desk etc. along with the act to carry. Even in such a case, in order to operate apparatus normally, it is required to raise the shock resistance of a magnetic-disk driving device, and shock resistance is demanded of the motor carried in a magnetic-disk driving device.

[0010] JP,H8-189525,A is one of those have prepared the hole in radial bearing and a thrust bearing. As shown in drawing 11 , the circulation way 19 is formed among the radial bearings 8a and 8b, the axial direction slot 22 is formed between a bearing 20 and the bearing housing 21, and the circuit of a magnetic fluid is formed in it. Moreover, it has the pouring hole 24 and the air extraction hole 25 on the cap 23, and after pouring in a magnetic fluid, said pouring hole 24 and the air extraction hole 25 are blockaded. It aims at keeping air from preventing the temperature rise of a magnetic fluid, and remaining at the time of pouring of a magnetic fluid by such composition. However, with the above-mentioned composition, the magnetic fluid is sealed inside the dynamic pressure bearing with the magnetic fluid seal 10, and is not open for free passage with the open air. Therefore, when the temperature of the dynamic pressure bearing part by which it was operated or neglected and the motor was sealed under hot environments rose, and the volume inside a dynamic pressure bearing expanded, the magnetic fluid seal 10 was damaged and there was a possibility of having produced faults, such as an outflow of a magnetic fluid, and spoiling a bearing function.

[0011] Moreover, with the conventional composition indicated to JP,H7-326121,A, when the motor carried in the magnetic-disk driving device carries out a high velocity revolution, there is a possibility of producing fine vibration by neither the surge of the race side of a ball bearing nor the accuracy of the ball itself being good etc. Moreover, when dropping a magnetic-disk driving device, there is a possibility that fine vibration may be generated and it may not rotate normally, by producing ****, a dent, etc. in the race side or ball of a ball bearing. When there was a possibility that NRRO may produce the fault which becomes large that noise becomes large, by this fine vibration, the technical problem were weak occurred to the shock.

[0012] This invention solves such a conventional technical problem, and even if the motor carried in a magnetic-disk driving device carries out a high velocity revolution, NRRO is small and are low power and low noise, its air cleanliness class is low and it aims at offering a powerful motor to a shock-proof.

[0013]

[Means for solving problem] The shaft at which this invention supports a hub in order to solve the above-mentioned technical problem, and in order to support a hub, use two radial bearings and thrust bearings and a gas dynamic pressure bearing is constituted. By installing a magnetic fluid seal in at least the both ends or one end of a part which constitutes a gas dynamic pressure bearing, the space field of a gas dynamic pressure bearing part is constituted in a hub inner side, and the free passage hole from the open air to said space field is prepared in the part which counters a shaft or a shaft peripheral face.

[0014] Since a solid of revolution rotates by non-contact mechanically by a gas dynamic pressure bearing even if the motor carried in a magnetic-disk driving device carries out a high velocity revolution by this, silence, low axis loss, and deflection are high precision, and shock resistance can be improved. Even if dust should occur in a bearing part, dust is kept from going to a magnetic disk by preparing a magnetic fluid seal and having a free passage hole to said space field of the open air and a hub inner side simultaneously. Thus, by constituting, NRRO is small and are low power and low noise, and an air cleanliness class can be low and can offer a powerful motor to a shock-proof.

[0015]

[Mode for carrying out the invention] The hub which invention of this invention according to claim 1 carries a magnetic disk, and is rotated, Said hub, the magnet which rotates by one, and the shaft which supports said hub, In order to support said hub, use two radial bearings and thrust bearings and a gas dynamic pressure bearing is constituted. The space field of a gas dynamic pressure bearing part is constituted in said hub inner side by installing a magnetic fluid seal in at least the both ends or one end of a part which constitutes said gas dynamic pressure bearing. It is considered as the BURASHIRESU motor characterized by preparing the free passage hole from the open air to said space field in said shaft. By carrying a gas dynamic pressure bearing, it can sway from it being non-contact mechanically, accuracy, silence, and shock resistance can improve, and axial loss can be reduced from the lubricant of a bearing being gas. Moreover, since the bearing part is separated from the space of the hub inner side with the magnetic fluid seal, even if dust should occur in a bearing part, it can prevent dust reaching to a magnetic disk.

[0016] In invention of this invention according to claim 2, a free passage hole is an approximate circle form, and the diameter D1 of said free passage hole receives the diameter D2 of said shaft. the rigidity of the shaft which considers it as the BURASHIRESU motor according to claim 1 by which the relation between D1/D2 <=0.3 is materialized, and does not have a free passage hole when the relation between the diameter D1 of a free passage hole and the diameter D2 of a shaft is D1/D2<=0.3, and abbreviation -- it becomes equivalent and becomes strong to external force-proof, such as a shock.

[0017] The hub which invention of this invention according to claim 3 carries a magnetic disk, and is rotated, Said hub, the magnet which rotates by one, and the shaft which supports said hub, In order to support said hub, use two radial bearings and thrust bearings and a gas dynamic pressure bearing is constituted. The space field of a gas dynamic pressure bearing part is constituted in said hub inner side by installing a magnetic fluid seal in at least the both ends or one end of a part which constitutes said gas dynamic pressure bearing. It is considered as the BURASHIRESU motor characterized by preparing the free passage hole from the open air to said space field in the part which counters said shaft peripheral face. By carrying a gas dynamic pressure bearing, it can sway from it being non-contact mechanically, accuracy, silence, and shock resistance can improve, and axial loss can be reduced from the lubricant of a bearing being gas. Moreover, since the bearing part is separated from the space of the hub inner side with the magnetic fluid seal, even if dust should occur in a bearing part, it can prevent dust reaching to a magnetic disk. Furthermore, since a free passage hole is processed on a shaft radial direction and a hole processing size becomes small, detailed hole processing is attained, and thin shape-ization of a motor can be realized by making between two radial bearings small.

[0018] By the opening part of a free passage hole using invention of this invention according to claim 4 as the BURASHIRESU motor of a description at either of 3 from Claim 1 installed between two radial bearings, and installing a free passage hole between two radial bearings Influence of the free passage hole to two radial bearings can be made equivalent, and radial bearing can be stabilized.

[0019] Invention of this invention according to claim 5 considers it as the BURASHIRESU motor of a description at either of 3 from Claim 1 which has a ventilation filter to the opening part of a free passage hole. Even if dust should occur in a gas dynamic pressure bearing part when a motor carries out intermittent operation by installing a ventilation filter in the free passage hole which leads to the space of the hub inner side, the situation where dust mixes to the space of a hub inner side, and dust reaches to a magnetic disk

can be prevented.

[0020] In the opening part to which a free passage hole results in the open air in invention of this invention according to claim 6 By constituting a labyrinth seal in the stator side which is the BURASHIRESU motor according to claim 3 which constitutes a labyrinth seal according to a hub face and the stator side which counters said hub face, and counters a hub face and a hub face Even if dust should occur in a gas dynamic pressure bearing part when a motor carries out intermittent operation, the situation where dust mixes to the space of a hub inner side, and dust reaches to a magnetic disk can be prevented.

[0021]

[Working example] The work example of this invention is explained below, referring to Drawings.

[0022] (Work example 1) The shaft 2 which has the free passage hole 1 in drawing 1 is supporting the thrust board 3, and is being fixed to the bracket 4. When the diameter of D1 and a shaft 2 is set to D2, the diameter of the free passage hole 1 is provided in D1 and D2 so that the relation between D1/D2 <=0.3 may be realized. Even if there are few thrust boards 3, on one side, the HERINGU bone slot is formed of etching processing or coining processing, and the thrust bearing of a gas dynamic pressure bearing is formed. Although the thrust board 3 is being pressed fit and fixed to the shaft 2, when intensity is still more nearly required, adhesives are used together, it may press fit to a shaft 2 or a shaft 2 and the thrust board 3 may be reinforced by laser welding. The hub 6 which constitutes a solid of revolution is supported by the shaft 2, and is installing the magnet 7 in hub inner skin. Two radial bearings 8a and 8b of a gas dynamic pressure bearing are constituted by a shaft 2 and the hub inner skin which counters, and the HERINGU bone slot is formed on a shaft side or hub inner skin. Camfering is prepared in the hub face which hits the entrance of the radial bearings 8a and 8b so that oil supply in a radial bearing part may be performed convenient. The free passage hole 1 is carrying out the opening between these two radial bearings. The opening of the free passage hole 1 is carried out also to the shaft end face, and the ventilation filter 9 is installed in the part. Under the radial bearing 8b, the magnetic fluid seal 10 fixed to the hub 6 is arranged, and the space field of a gas dynamic pressure bearing part and a hub inner side is separated. The stator core 11 is being fixed to the bracket 4 by press fit, adhesion, or press fit adhesion, and it is arranged so that a magnetic center may be aligned with a magnet 7. When it is necessary to raise the rigidity of a thrust bearing further, it may arrange so that the center position of a magnet 7 may be shifted up to the center position of a stator core 11, and the rigidity of a thrust bearing may be reinforced according to the effect of magnet power of absorption.

[0023] By the above-mentioned composition, it becomes non-contact mechanically by carrying a gas dynamic pressure bearing in the first place at the time of motorised. by the machining accuracy of a ball or a race side influencing and producing fine vibration, and making it non-contact mechanically by a gas dynamic pressure bearing, although there was a possibility of worsening deflection accuracy and silence, in the case of the ball bearing which contacts mechanically, deflection accuracy and silence can be boiled markedly, and it can raise them. The lubricant of the dynamic pressure bearing is making it the second not with a liquid but with gas. Since the viscosity rise with the degree of low temperature which is looked at by the liquid is not remarkable with gas with that, while being able to reduce remarkably the axial loss with the degree of low temperature, it contributes also to motor power-saving by axial loss reduction. To the third, the gas dynamic pressure bearing part is separated from the space field of the hub inner side with the magnetic fluid seal. Even if dust should occur when a motor carries out the sampling action of ON-OFF and a gas dynamic pressure bearing contacts A magnetic fluid seal prevents beforehand that the dust which dust protected

entering to the space field of a hub inner side from the gas dynamic pressure bearing part, and produced in the gas dynamic pressure bearing part reaches to a magnetic disk. The space field and the open air of the gas dynamic pressure bearing part which were shut by the hub inner side with the magnetic fluid seal are made to open for free passage by forming the free passage hole 1 in the fourth at a shaft 2. When the temperature of the environment rises, the gas of the space field of a gas dynamic pressure bearing part expands, and volume increases. Since a part for the volume which expanded cannot be missed when there is no free passage hole 1, a magnetic fluid seal will be damaged. However, since the volume which expanded by constituting the free passage hole 1 can be missed in the open air through the free passage hole 1, a gas dynamic pressure bearing part can be separated from the space field of a hub inner side, without spoiling the function of a magnetic fluid seal. In the fifth, the diameter D1 of the free passage hole 1 and the diameter D2 of a shaft 2 constitute so that it may be the relation between D1/D2 <=0.3. The figure showing the relation between a shaft boss ratio and a deflection ratio is expressed to drawing 2 . A horizontal axis is the boss ratio of a shaft and is the ratio of the diameter D1 of the free passage hole 1 to the outer diameter D2 of a shaft 2. On the other hand, a vertical axis is a deflection ratio, forms the amount delta of deflection when a free passage hole changes D1 on the basis of the amount delta of deflection of the shaft of D1=0 (D1=0) into a-less dimension, and expresses it as deflection ratio delta/delta (D1=0). The amount delta of deflection of the shaft itself has a large portion depending on second-moment-of-area I shown in (a formula 1).

[0024]

I=pi/64x (D24-D14) ..... (formula 1)

The diameters D2 of a shaft are about 2<=12mm of 2 mm<=D, and if they become larger than 12mm, its axial loss will increase too much and they will affect power-saving. When it is less than 2mm, the centrifugal force produced by rotor unbalance at the time of a high velocity revolution makes the deflection of a shaft increase, it sways, and there is a possibility of producing fault, such as having influence to accuracy. By setting the diameter D2 of a shaft as 2<=12mm of 2 mm<=D, said fault is avoidable. A deflection ratio can be made into less than 1.01 when a shaft boss ratio is 0.3 or less, as shown in drawing 2 . That is, by constituting in D1/D2 <=0.3, even if it is possible to compare the case where there are the amount of deflection and free passage hole of a shaft without a free passage hole, and to consider that it is equivalent in less than 1% of range and it has a free passage hole, shaft rigidity is hardly affected. Or it goes into design tolerance tolerance enough. The opening of the free passage hole 1 is carried out [sixth] among the radial bearings 8a and 8b. Since influence affect two radial bearings 8a and 8b of the free passage hole 1 can be equalized to both by this composition, the stability of radial bearing is securable. In the seventh, it has the ventilation filter 9 at the shaft end face. This composition can prevent the dust of the open air from entering to a gas dynamic pressure bearing part, and the lock of the bearing part by a foreign substance can be prevented.

[0025] (Work example 2) in drawing 3 , the free passage hole 1 is formed in the shaft 2, and the free passage hole 1 is arranged so that two radial bearings 8a and 8b may be put, respectively -- the upper and lower sides of the radial bearing 8a, and the radial bearing 8b -- the free passage hole 1 is carrying out the opening up and down. Moreover, the thrust board 3 is installed in a shaft 2, and the free passage hole 1 is carrying out the opening to the shaft end face also to the thrust bearing part which consists of thrust strike plates 5 which meet the thrust board 3. The thrust board 3 uses press fit or adhesives together at a shaft 2,

and is pressed fit in it, and the thrust strike plate 5 is installed in the hub 6. Since it has a HERINGU bone slot on the field which counters the thrust strike plate 5 of the thrust board 3 and thrust bearing rigidity is increased, a HERINGU bone slot may be prepared also on the opposite side of the thrust board 3.

[0026] Thus, since three dynamic pressure bearings of two radial bearings and thrust bearings are classified by the free passage hole 1 and it becomes independent with constituting, it can prevent that the dynamic pressure or the negative pressure generated in each bearing affects other bearings mutually. And it becomes possible by making each bearing become independent to secure each bearing rigidity.

[0027] (Work example 3) In drawing 4 , the free passage hole 1 is formed in the shaft 2. The ventilation filter 9a is stuck on the shaft end-face part of the direction currently fixed to the bracket 4 with an adhesion seal or adhesives so that the opening of the free passage hole 1 may be closed. On the other hand, the screw stop of the thrust board 3 is carried out to the shaft end-face part of another side to the shaft 2 with the thrust screw 12. The hub 6 is supporting the thrust strike plate 5, and the thrust strike plate 5 is supporting the magnetic fluid seal 10a. Under the two radial bearings, the magnetic fluid seal 10b is installed in the hub 6, and the space field is established in the inside of a hub by putting the magnetic fluid seal 10a and a gas dynamic pressure bearing part. The HERINGU bone slot is formed on the field of the thrust board 3 which counters the thrust strike plate 5, since the bearing rigidity of the direction of thrust is increased, it passes on meeting of the thrust board 3, and a ring bone slot may be formed. The ventilation filter 9b is installed in the female screw part of the shaft 2 with which the thrust screw 12 is concluded. When carrying out conclusion fixation of the thrust board 3 with the thrust screw 12 at a shaft 2, there is a possibility that a motor may take for rotating that the thrust screw 12 is a right screw and the direction of motor revolving is counter clockwise, and the thrust screw 12 may loosen. In order [the] to make the joint strength of a shaft 2 and the thrust board 3 increase as a measure stop loosening, as shown in drawing 5 , after performing press fit or crevice BAME for the thrust board 3 to a shaft 2, laser welding 13a and 13b may be performed annularly, and a fitting part may be fixed. When margins of enough are in the joint strength of the thrust board 3, the laser welding 13a or one laser welding of 13b is sufficient. The ventilation filter 9 is installed in the female screw part of a shaft 2.

[0028] Thus, with constituting, it becomes possible to realize a shaft both-ends support type gas dynamic pressure bearing motor, and since the machine rigidity of the stator supporting the rotor of a motor improves, also in high-velocity-revolution-izing, a rotor can be stabilized and it can rotate. Therefore, since the deflection accuracy which was getting worse by machine rigidity improves, the deflection accuracy of a motor improves and high-velocity-revolution-izing of a magnetic-disk driving device and high capacity-ization are made realizable.

[0029] (Work example 4) In drawing 6 , the free passage hole 1 is formed in the shaft 2, and the ventilation filter 9 is installed in the opening part of the shaft end face of the free passage hole 1 by adhesion etc. It is being fixed to the shaft 2 by press fit or press fit adhesion, and the thrust board 3 may carry out laser welding for the improvement in joint strength of the thrust board 3. Two radial bearings are constituted by the shaft 2 and the sleeve 14 which counters, and caulking fixation of the thrust strike plate 5 is carried out at the sleeve 14. Adhesion fixing of the magnetic fluid seal 10 is carried out to the sleeve 14, and it has a space field inside the sleeve. And said space field and the open air are connected by the free passage hole 1. moreover, the sleeve 14 -- a bracket 4 -- press fit -- or adhesion fixing is carried out.

[0030] Thus, it becomes possible to realize the gas dynamic pressure bearing motor of a shaft rotary type

with constituting. Since a hub 6 does not need to constitute radial bearing compared with a shaft fixed mount type, only the part can make rotor weight a shaft rotary type reduce. Since the load to a bearing becomes small by this rotor weight saving, it becomes strong to external force, such as a shock, vibration, and rocking.

[0031] (Work example 5) In drawing 7 , two radial bearings 8a and 8b are formed in the inner skin of the hub 6 which counters a shaft 2 and it. The opening of the free passage hole 1 is carried out between said two radial bearings 8a and 8b of a hub 6, and direction of the free passage hole 1 is perpendicularly prepared to a shaft 2. The ventilation filter 9 is installed in the part from the gas dynamic pressure bearing part of the free passage hole 1 to the space field of a hub inner side.

[0032] In drawing 8 , the free passage hole 1 is formed in the hub 6, and the labyrinth seal 15 is constituted from a gas dynamic pressure bearing part of the free passage hole 1 by the part which reaches the space field of a hub inner side. The labyrinth seal 15 is arranged around [an opening part] the free passage hole 1, and is constituted by the peripheral face of the radial bearing composition part of a hub 6, and the inner skin of the bracket 4 which counters said peripheral face.

[0033] In drawing 9 , the free passage hole 1 is formed in the sleeve 14 currently fixed to the bracket 4, and the labyrinth seal 15 is constituted from a gas dynamic pressure bearing part of the free passage hole 1 by the part which reaches the space field of a hub inner side. The labyrinth seal 15 is arranged around [an opening part] the free passage hole 1, and is constituted by the peripheral face of a sleeve 14, and the inner skin of the hub 6 which counters said sleeve peripheral face.

[0034] Thus, with constituting, since the space field of a gas dynamic pressure bearing part and a hub inner side is connected in the free passage hole 1, even if the air of a gas dynamic pressure bearing part expands at high temperature, an expanded part escapes to the space field of a hub inner side, and breakage of a magnetic fluid seal can be prevented beforehand. Moreover, since the hole processing direction turns into a shaft radial direction in order not to prepare a free passage hole in a shaft 2 and to carry out hole processing to a hub 6 or a sleeve 14, and a processing size becomes small, detailed hole processing becomes easy. Since the gap of two radial bearings can be narrowed by enabling detailed hole processing, thin shape-ization of a motor is attained and a thin magnetic-disk driving device can be realized.

[0035]

[Effect of the Invention] According to invention according to claim 1, by carrying a gas dynamic pressure bearing, it can sway from it being non-contact mechanically, accuracy and silence can improve, and axial loss can be reduced from the lubricant of a bearing being gas so that clearly from a description of the form of the above-mentioned implementation. Moreover, since the bearing part is separated from the space field of the hub inner side with the magnetic fluid seal, even if dust should occur in a bearing part, the advantageous effect that it can prevent dust reaching to a magnetic disk is acquired.

[0036] moreover, the rigidity of the shaft which does not have a free passage hole when the relation between the diameter D1 of a free passage hole and the diameter D2 of a shaft is D1/D2<=0.3 according to invention according to claim 2 and abbreviation -- the effect of becoming equivalent and becoming strong to external force-proof, such as a shock, is acquired.

[0037] Moreover, according to invention according to claim 3, by carrying a gas dynamic pressure bearing, it can sway from it being non-contact mechanically, accuracy and silence can improve, and axial loss can be reduced from the lubricant of a bearing being gas. Moreover, since the bearing part is separated from the

space field of the hub inner side with the magnetic fluid seal, even if dust should occur in a bearing part, it can prevent dust reaching to a magnetic disk. Furthermore, since detailed hole processing of a free passage hole is attained and between two radial bearings can be made small, the effect that thin shape-ization of a motor is realizable is acquired.

[0038] Moreover, according to invention according to claim 4, by installing a free passage hole between two radial bearings, influence of the free passage hole to two radial bearings is made equivalent, and the effect that radial bearing can be stabilized is acquired.

[0039] Moreover, by installing a ventilation filter in the free passage hole which leads to the space field of the hub inner side according to invention according to claim 5 Even if dust should occur in a gas dynamic pressure bearing part when a motor carries out intermittent operation, the effect that the situation where dust mixes to the space field of a hub inner side, and dust reaches to a magnetic disk can be prevented is acquired.

[0040] Moreover, by constituting a labyrinth seal in the stator side which counters a hub face and a hub face according to invention according to claim 6 Even if dust should occur in a gas dynamic pressure bearing part when a motor carries out intermittent operation, the effect that the situation where dust mixes to the space field of a hub inner side, and dust reaches to a magnetic disk can be prevented is acquired.

[Brief Description of the Drawings]

[Drawing 1] The sectional view of the motor in which the work example 1 of this invention is shown

[Drawing 2] The figure for explaining the relation between the free passage hole in the work example 1 of this invention, and the diameter of a shaft

[Drawing 3] The sectional view of the motor in which the work example 2 of this invention is shown

[Drawing 4] The sectional view of the motor in which the work example 3 of this invention is shown

[Drawing 5] The sectional view showing conclusion of the shaft in the work example 3 of this invention, and a thrust board

[Drawing 6] The sectional view of the motor in which the work example 4 of this invention is shown

[Drawing 7] The sectional view of the motor in which the work example 5 of this invention is shown

[Drawing 8] The sectional view of the motor in which the work example 5 of this invention is shown

[Drawing 9] The sectional view of the motor in which the work example 5 of this invention is shown

[Drawing 10] The sectional view of the motor in which conventional parallel is shown

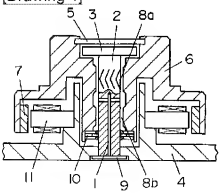
[Drawing 11] The sectional view of the motor in which conventional parallel is shown

[Explanations of letters or numerals]

1 Free Passage Hole
2 Shaft
3 Thrust Board
4 Bracket
5 Thrust Strike Plate
6 Hub
7 Magnet

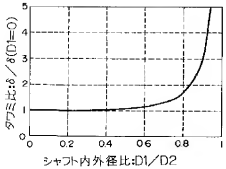
8a, 8b Radial bearing
9, 9a, 9b Ventilation filter
10, 10a, 10b Magnetic fluid seal
11 Stator Core
12 Thrust Screw
13a, 13b Laser welding
14 Sleeve
15 Labyrinth Seal
16 Ball Bearing
17 Spindle Hub Drive Motor
18 Open Air Part Vent Hole
19 Circulation Way
20 Bearing
21 Bearing Housing
22 Axial Direction Slot
23 Cap
24 Pouring Hole
25 Air Extraction Hole
D1 Diameter of a free passage hole
D2 Diameter of a shaft

[Drawing 1]

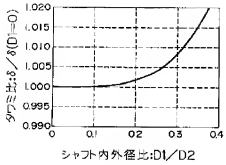


[Drawing 2]

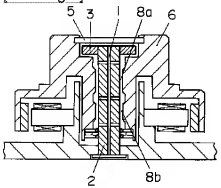
(a)



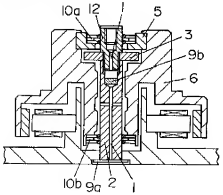
(b)



[Drawing 3]



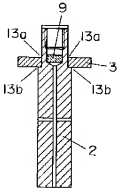
[Drawing 4]



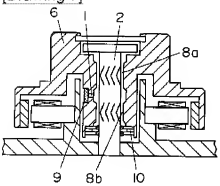
[Drawing 5]

(a)

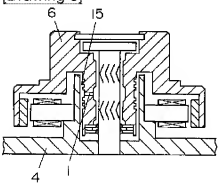
(b)



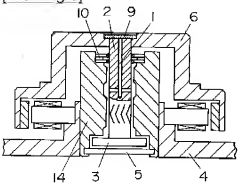
[Drawing 7]



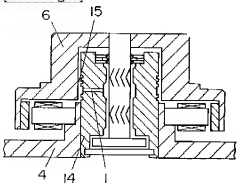
[Drawing 8]



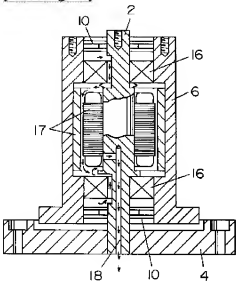
[Drawing 6]



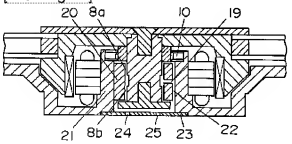
[Drawing 9]



[Drawing 10]



[Drawing 11]



[Translation done.]